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DISTRIBUTION AND RELATIVE ABUNDANCE OF COMMERCIALLY IMPORTANT PANDALID SHRIMPS IN THE NORTHEASTERN PACIFIC OCEAN

by Lael L. Ronholt

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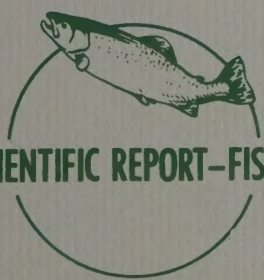

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DISTRIBUTION AND RELATIVE ABUNDANCE OF COMMERCIALLY IMPORTANT PANDALID SHRIMPS IN THE NORTHEASTERN PACIFIC OCEAN

by

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ABSTRACT

Data resulting from exploratory fishing on 18 cruises of the Bureau of Commercial Fisheries exploratory fishing vessel *John N. Cobb* from 1950-60 were analyzed to determine the average catch of shrimp per unit of effort and per 10-fathom depth interval in each of four areas: Oregon and Washington, Southeastern Alaska, central Alaska, and Alaska Peninsula. The five species of shrimp encountered were: *Pandalus jordani*, *P. borealis*, *P. hypsinotus*, *P. platyceros*, and *Pandalopsis dispar*. Gulf of Mexico shrimp trawls and West Coast beam trawls were the major gear used during the explorations.

INTRODUCTION

The Bureau of Commercial Fisheries research vessel *John N. Cobb* has made 18 cruises in the past decade (table 1) to locate and assess latent shrimp resources from southern Oregon to the Alaska Peninsula. Data from the cruises were examined to provide information on the general distribution and relative abundance of commercially important pandalid shrimps found adjacent to Oregon, Washington, and Alaska. Off British Columbia, only the waters near Cape Beale were explored by the *Cobb*. Explorations conducted in British Columbia waters by the Fisheries Research Board of Canada (Butler and Legare, 1954; Butler and Dubokovic, 1955a and 1955b) are not included herein.

GEAR AND METHODS

Sampling devices used in the explorations included beam trawls, Gulf of Mexico type flat and semiballoon shrimp trawls, fish trawls, and several types of shrimp traps. Only the beam trawls and Gulf shrimp trawls were used extensively enough to give adequate

TABLE 1.--Areas explored, 1950-60

Year	Months	Gear	Area of exploration	Reference	Cruise number
1950	March-April	B. T.[1]	Ketchikan area	Schaefers, 1951	4
1950	Oct. - Dec.	" "	Southern Chichagof-Northern Baranof Island area	Schaefers, 1951	6
1951	March-April	" "	Lynn Canal, Stephens Passage, Icy Strait & Keku Strait area	Ellson and Livingstone, 1952	7
1952	March-April	" "	Glacier Bay and other scattered areas	Schaefers, 1953	10
1953	March-April	" "	Yakutat Bay	Schaefers and Smith, 1954	15
1954	April	" "	Prince William Sound	Schaefers, Smith, and Greenwood, 1955	18
1954	July - Sept.	" "	Prince William Sound	Schaefers, Smith, and Greenwood, 1955	20
1955	Oct. - Nov.	B. T. G. S. T.[2]	Long Beach, Wash. to Cape Alava, Wash.	Schaefers and Johnson, 1957	24
1956	Feb. - March	B. T.	Strait of Juan de Fuca	Greenwood, 1957	25
1956	March-April	B. T. G. S. T.	Long Beach, Wash. to Destruction Island, Wash.	Schaefers and Johnson, 1957	26
1957	June	G. S. T.	South and West of Baker Island	Greenwood, 1958	32A
1957	September	" " "	Shumagin Islands and Stepovak Bay to Unalaska Island	Johnson, 1959	32B
1958	March-April	" " "	Cape Foulweather, Oreg. to Columbia River	Alverson, McNeely, and Johnson, 1960	36
1958	May	" " "	Point Grenville, Wash. to Cape Beale, Vancouver Island, B. C.	Alverson, McNeely, and Johnson, 1960	37
1958	June	" " "	Cape Foulweather, Oreg. to Columbia River	Alverson, McNeely, and Johnson, 1960	38
1958	July-August	" " "	Kodiak Island to Pye Islands	Greenwood, 1959	39
1958	Oct. - Nov.	" " "	Oregon and Washington coasts	Alverson, McNeely, and Johnson, 1960	40
1959	Oct. - Nov.	" " "	Prince William Sound and Puget Bay to Pye Islands	Wathne and Johnson, 1961	44
1960	Sept. - Nov.	" " "	Coquille River, Oreg. to Yaquina Bay, Oreg.	Ronholt and Magill, 1961	48

[1] Beam trawl
[2] Gulf shrimp trawl

samples of shrimp inhabiting the various areas.

Although commercial beam trawls are as large as 40 feet, a 20-foot beam trawl was used for these explorations to facilitate handling. The beam trawl "D" frame was constructed of 5/8-inch by 6-inch bar iron and the net of 1 1/2-inch stretched[1] mesh cotton webbing (Ellson and Livingstone, 1952).

[1] All net measurements are center of one knot to center of next knot.

A Gulf of Mexico shrimp trawl (Schaefers and Johnson, 1957) measuring 41 feet 3 inches along the head rope was first used in 1955-56 off Washington. It subsequently became the major exploratory shrimp gear. The trawl was attached immediately behind the otter doors, which were fastened to a single warp line by a 25-fathom bridle. Each otter door was 2 1/2 feet high by 5 feet long. The net was constructed of 1 1/2-inch stretched mesh cotton webbing.

During early cruises, attempts to locate trawlable bottom were made by sounding

areas shown on charts as having soft mud bottom. When the echo sounder indicated that the bottom was level enough to permit trawling, the net was fished. Considerable gear damage often resulted, for the echo sounder recording did not always enable us to interpret the bottom type correctly. During more recent cruises the use of a high-resolution, low-frequency echo sounder provided better definition of bottom configuration and type, thus reducing gear damage and destruction (Hitz, Johnson, and Pruter, 1961). In most instances exploratory drags were 30 minutes long.

Known commercial shrimp grounds were not fished except when it was necessary to establish that the gear was functioning properly.

ANALYSIS OF DATA

To facilitate discussion, the region investigated has been divided into four areas as follows: Oregon and Washington, Southeastern Alaska, central Alaska, and the Alaskan Peninsula. The data were analyzed to determine the average catch per unit of effort by areas and by 10-fathom depth intervals within the areas. The depth of each haul was resolved as the median between the deepest and shallowest depths recorded for the particular fishing effort. Although in a few hauls the depth range varied considerably, the average depth variability per drag was approximately 6 fathoms. Yield rates reported here are based on 30-minute drags. All drags of more or less than 30 minutes have been equated to 30 minutes. As data are not available to calculate the difference in catch efficiency between the beam trawl and Gulf shrimp trawl, results obtained with each type of trawl are discussed separately.

Since the exploratory fishing surveys were not conducted with the objective of assessing total population sizes, and the explorations extended over 10 years, general conclusions on interarea abundance must be considered relative and perhaps more indicative of availability than of true abundance. Interarea comparisons were based on average catches after those hauls containing less than 1 pound of shrimp had been removed. The data have been examined to determine the species complexes present and other pertinent information on the resources within the areas.

Changes in environmental factors affecting shrimp survival may have influenced interyear or interarea abundance of the species investigated through the decade during which explorations were conducted. As no measures of the factors are available, it is impossible to estimate what effect they may have had on the shrimp populations. The relative abundance is discussed only as it was found during the explorations.

It is necessary to assume that the fishing gear gave an accurate estimate of the availability of the species present. As large production is not the purpose of exploratory fishing, no efforts were made to restrict fishing only to areas where higher catches occurred. The primary purpose was to sample all grounds on which shrimp gear could be operated.

To avoid confusion of names, the common and scientific names of the species discussed and the geographic range over which they were collected are given (table 2).

The average number and range in number of whole shrimp per pound per area are given in table 3.

INTRA-AREA DISTRIBUTION AND RELATIVE ABUNDANCE

Washington-Oregon

In 1955-60, seven exploratory cruises were made in waters adjacent to Oregon and Washington. These explorations covered the general area offshore from the Coquille River in Oregon to Cape Beale, Vancouver Island, and the Strait of Juan de Fuca. Sampling was conducted at depths ranging from 20 to 275 fathoms.

TABLE 2.--Scientific names, common names, and geographic ranges of commercially important species of pandalid shrimp encountered during explorations

Common name	Scientific name	Oregon	Washington	Strait of Juan de Fuca	Southeastern Alaska	Yakutat Bay	Prince William Sound	Prince William Sound to Cook Inlet	Cook Inlet to Alaska Peninsula
Pink	*Pandalus jordani*	X	X	X	X				
Pink	*Pandalus borealis*				X	X	X	X	X
Side-stripe	*Pandalopsis dispar*	X	X	X	X	X	X	X	X
Coon-stripe	*Pandalus hypsinotus*			X	X	X	X	X	X
Spot	*Pandalus platyceros*		X	X	X	X	X	X	

Table 3.--Average size and range of size for pandalid shrimps captured during exploratory operations

Area	Species	Whole shrimp per pound	
		Range	Average
		Number	*Number*
Oregon	*Pandalus jordani*	72-260	109
Washington	*Pandalus jordani*	90-240	136
Southeastern Alaska	*Pandalus borealis*	67-163	106
	Pandalopsis dispar	22-59	35
	Pandalus hypsinotus	20-60	34
Yakutat Bay	*Pandalus borealis*	61-128	90
	Pandalopsis dispar	21-39	30
Prince William Sound	*Pandalus borealis*	54-146	83
	Pandalopsis dispar	19-104	43
	Pandalus hypsinotus	8-71	30
Prince William Sound to the Pye Islands	*Pandalus borealis*	61-136	99
	Pandalopsis dispar	22-68	38
Pye Islands to Cape Douglas	*Pandalus borealis*	80-200	151
	Pandalopsis dispar	23-69	44
	Pandalus hypsinotus	16-84	31
Kodiak Island	*Pandalus borealis*	59-133	96
	Pandalopsis dispar	23-56	40
Alaska Peninsula	*Pandalus borealis*	68-227	152
	Pandalopsis dispar	26-160	72
	Pandalus hypsinotus	25-185	68

Four pandalid shrimps *(Pandolus jordani, P. platyceros, P. hypsinotus,* and *Pandalopsis dispar)* were caught, with *Pandalus jordani* being dominant. Along the Oregon coast, highest abundance[2] of *P. jordani,* was found off Tillamook Head, between Cape Meares and Cape Lookout, between Manhattan Beach and Cape Foulweather, and from Heceta Head to the Coquille River (fig. 1). *P. jordani* was taken at depths ranging from 50 to 250 fathoms with major concentrations occurring between 70 and 109 fathoms (table 4). The availability of shrimp at the extremes of this depth range dropped off rapidly.

Off the Washington coast, *Pandalus jordani* was caught in commercial concentrations from near Copalis Head, Grays Harbor to Willapa Bay, between Destruction Island and Lapush, and off Cape Flattery. Off Cape Beale, Vancouver Island, B.C. (fig. 2), *P. jordani* was taken at depths from 50 to 188 fathoms with highest catch rates occurring between 60 and 90 fathoms (table 5).

Small quantities of *Pandalopsis dispar* were taken over the Continental Shelf and Slope in hauls made between Manhattan Beach, Oreg. and Cape Beale, Vancouver Island. The shrimp occurred at depths ranging from 50 to 200 fathoms. *Pandalus platyceros,* was also taken in small numbers north of Lapush, Wash., at depths between 50 and 137 fathoms. *P. hypsinotus* was not taken in hauls made in offshore waters, but small quantities were captured in the Strait of Juan de Fuca.

TABLE 4.--Catch per unit of Gulf shrimp trawl effort by depth for *Pandalus jordani* taken off Oregon in 1958 and 1960

Depth	1/2-hr. effort	Total catch	Average catch per 1/2 hour	Effort taking shrimp	Average for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
< 50	0	0	0	0	0	--
50-59	2	35	18	2	18	5-30
60-69	15	154	10	7	22	2-70
70-79	35	3,954	113	33	120	1-445
80-89	42	5,695	136	40	142	1-675
90-99	44	6,065	138	42	144	1-650
100-109	9	656	73	6	109	10-300
> 109	39	489	13	9	54	1-350
TOTAL	186	17,048		139		1-675
Averages			92		123	

Southeastern Alaska

Between 1952 and 1956, five cruises were made in the Southeastern Alaska area, mostly in the passages and bays. Explorations extended from Dixon Entrance to Cape Spencer, and sampling was conducted at depths ranging from 13 to 225 fathoms. Pandalid shrimps

[2] As discussed in the text, high abundance of *P. jordani* and *P. borealis* was arbitrarily taken as greater than 200 pounds per 30 minutes fished for the gulf shrimp trawl and 100 pounds per 30 minutes fished for the beam trawl. High abundance of *Pandalopsis dispar* was 100 pounds per 30 minutes fished for the Gulf shrimp trawl and 50 pounds per 30 minutes fished for the beam trawl.

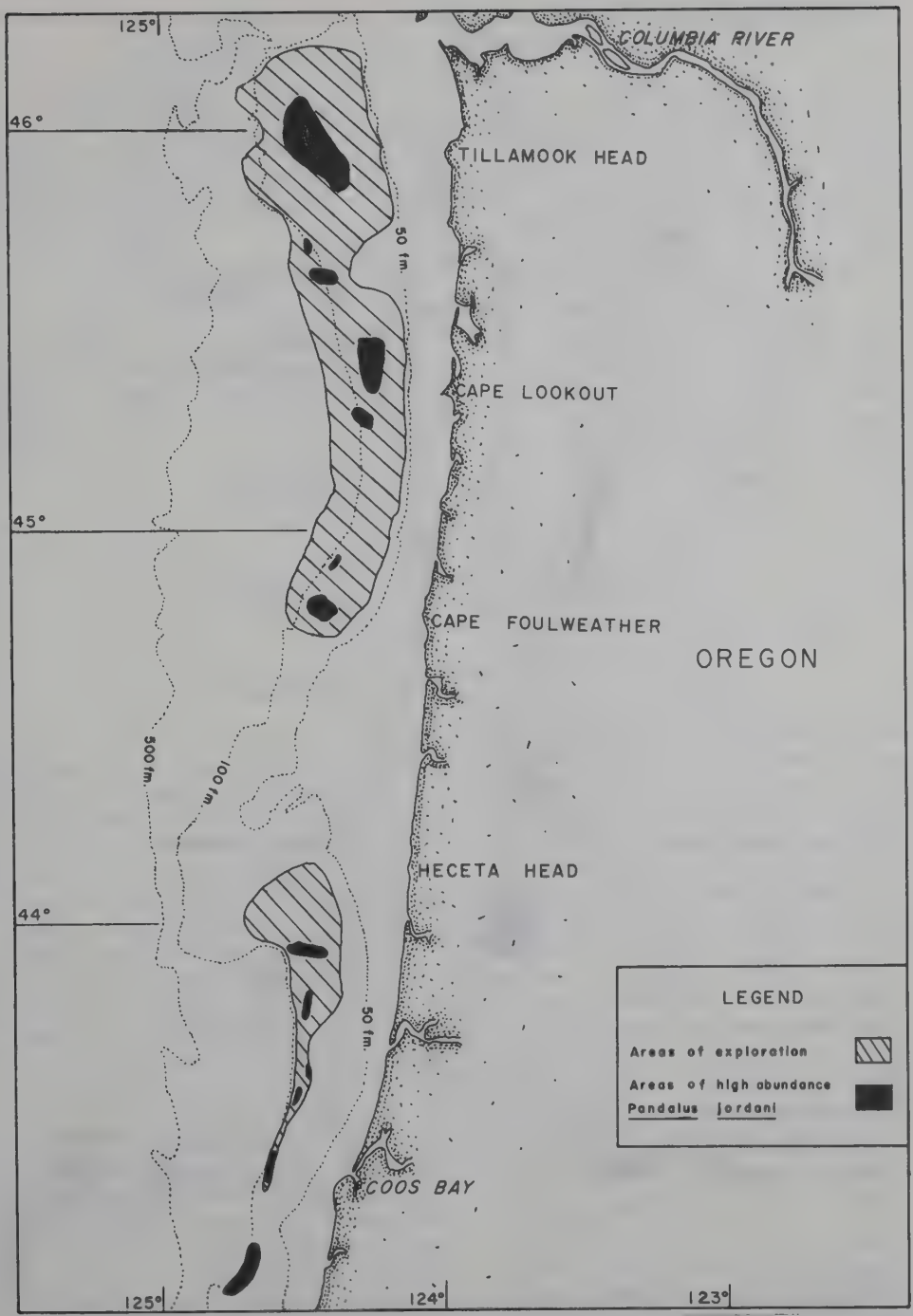

Figure 1.--Areas of exploration for and high abundance of *Pandalus jordani*, Oregon, 1950-60.

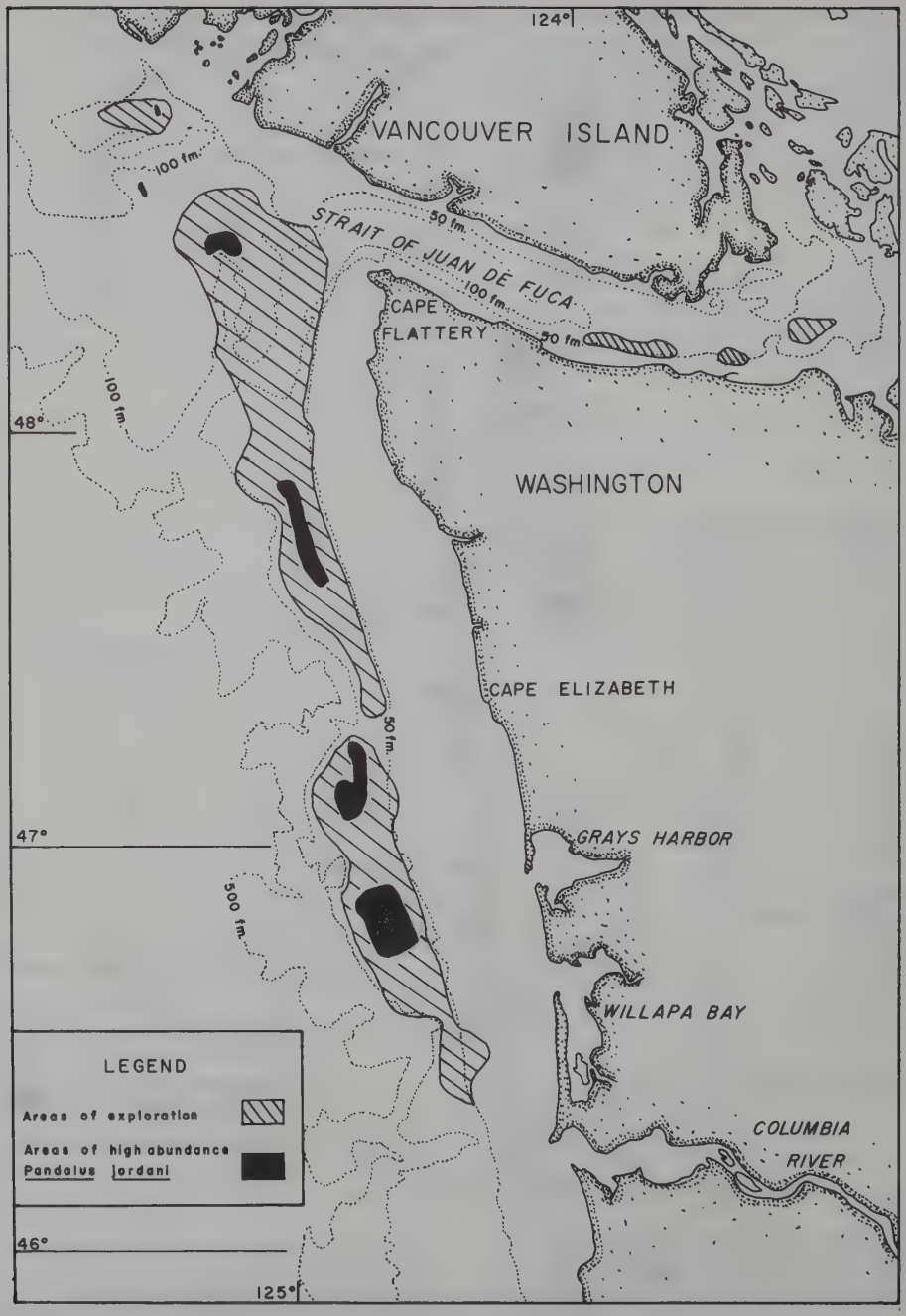

Figure 2.--Areas of exploration for and high abundance of *Pandalus jordani*, Washington, 1950-60.

TABLE 5.--Catch per unit of Gulf shrimp trawl effort by depth for *Pandalus jordani* taken off the Washington Coast in 1956 and 1958

Depth	1/2-hr. effort	Total catch	Average catch per 1/2 hour	Effort taking shrimp	Average for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
< 50	0	0	0	0	0	--
50-59	6	243	41	3	81	3-120
60-69	35	6,960	199	29	240	40-750
70-79	27	11,441	424	27	424	4-1,100
80-89	16	1,972	123	16	123	3-350
90-99	4.5	206	46	3.5	59	6-113
100-109	5	251	50	3	84	6-180
> 109	12	13	1	3	4	3-30
TOTAL	105.5	21,086		84.5		3-1,100
Averages			200		250	

taken included *Pandalus borealis*, *P. jordani*, *P. hypsinotus*, *P. platyceros*, and *Pandalopsis dispar*. *Pandalus borealis* was dominant. Commercial concentrations of *P. borealis* were noted in Idaho Inlet, Stephens Passage, Lynn Canal, Keku Strait, and Glacier Bay. Fair concentrations were also observed in Gilbert Bay, Port Frederick, Icy Strait, Fish Bay, Katlian Bay, and off Baker Island (fig. 3). *P. borealis* was taken in depths ranging from 13 to 178 fathoms (table 6). Best catches were made in 30 to 70 fathoms; however, occasional good catches were also made as deep as 110 fathoms.

Although not commonly found in commercial quantities, *Pandolopsis dispar* was also taken throughout the Southeastern Alaska area. Best catches were made in Idaho Inlet and Port Snettisham. Fair concentrations were found in Gilbert Bay, Stephens Passage, Glacier Bay, Port Frederick, Affleck Canal, and Lynn Canal. *P. dispar* was captured at depths of 20 to 220 fathoms, with best catches being made between 50 and 120 fathoms (table 7).

Small quantities of *Pandalus hypsinotus* were taken in many of the bays and inlets of Southeastern Alaska. Highest catches occurred in Idaho Inlet, Tenakee Inlet, Keku Strait, Glacier Bay, Lynn Canal, and Saks Cove. As in the more southern waters off Washington and Oregon, this species was not found in hauls made offshore. Catches of *P. hypsinotus* were noted at depths ranging from 16 to 109 fathoms. *P. platyceros* also was taken only in small quantities, with the highest catch being made in Keku Strait. Both *P. hypsinotus* and *P. platyceros* appeared to be more prevalent in rocky areas, and their abundance may be much higher in areas unfishable by trawls. Occasional specimens of *P. jordani* were caught in Southeastern Alaska.

Central Alaska

From 1953 to 1959, five exploratory shrimp cruises were made in the central Alaskan area between Cape Spencer and western Kodiak Island. Sampling was conducted at depths from 15 to 233 fathoms. Species of pandalid shrimps

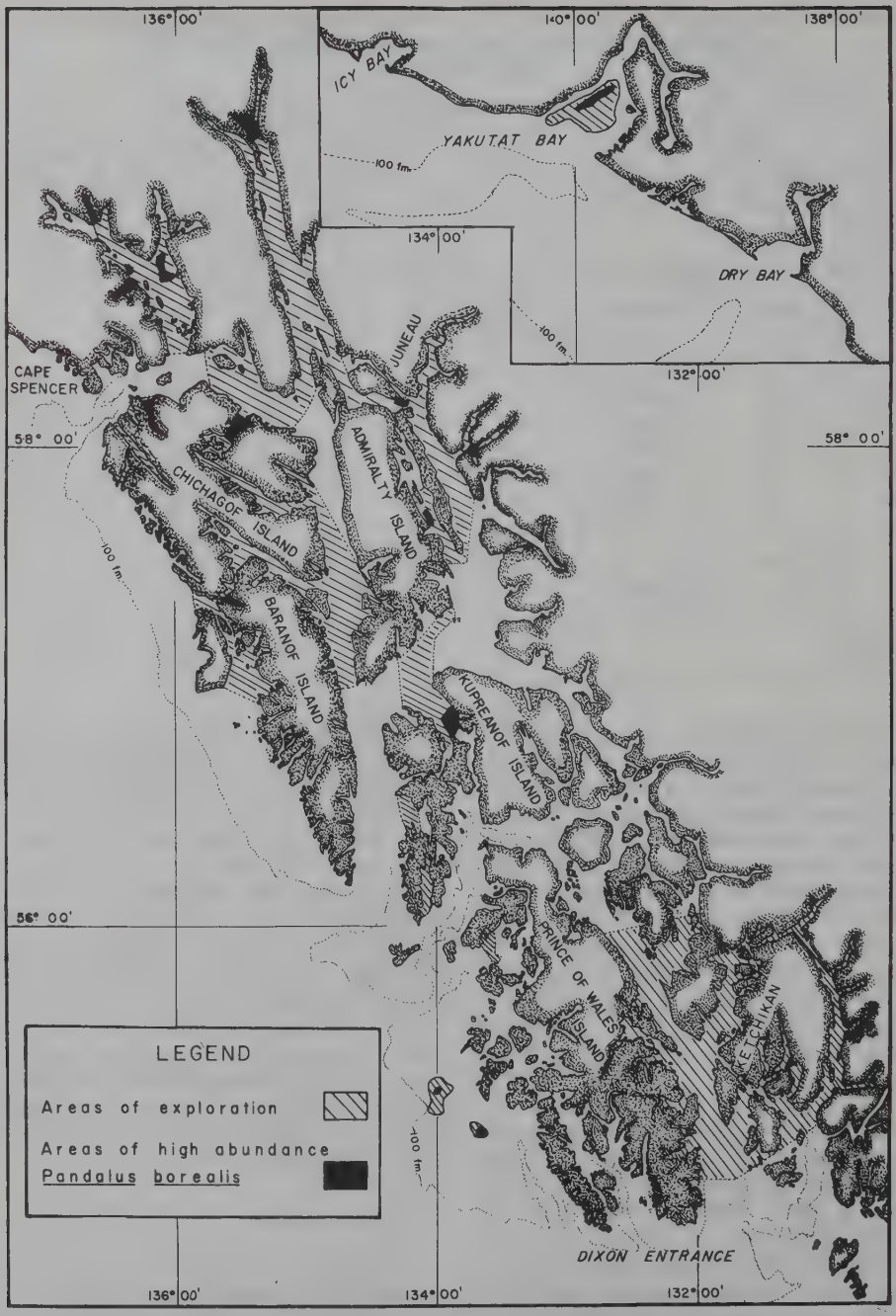

Figure 3.--Areas of exploration for and high abundance of *Pandalus borealis*, Southeastern Alaska, 1950-60.

Table 6.--Catch per unit of beam trawl effort by depth for *Pandalus borealis* taken in Southeastern Alaska in 1950-52

Depth	1/2-hr. effort	Total Catch	Average per 1/2 hour	Effort taking shrimp	Average catch for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
<30	22.8	408	19	7.0	58	1-350
30-39	25.9	2,805	108	13.2	213	13-700
40-49	45.7	2,306	51	28.7	80	1-500
50-59	33.9	1,777	52	28.2	63	1-278
60-69	46.8	2,142	46	33.1	65	1-200
70-79	41.1	1,122	27	26.6	42	1-138
80-89	36.7	673	18	20.9	32	2-99
90-99	25.5	517	20	17.6	29	2-210
100-109	10.2	253	25	4.6	55	1-144
>109	30.8	53	1.7	7.1	7	1-36
TOTAL	319.4	12,056		187.0		1-700
AVERAGES			38		64	

Table 7.--Catch per unit of beam trawl effort by depth for *Pandalopsis dispar* taken in Southeastern Alaska in 1950-52

Depth	1/2-hr. effort	Total catch	Average per 1/2 hour	Effort taking shrimp	Average catch for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
<50	94.4	298	3	12.0	25	1-200
50-59	33.9	209	6	9.1	23	1-84
60-69	46.8	331	7	31.5	11	1-50
70-79	41.1	634	15	30.0	21	1-90
80-89	36.7	1,098	30	32.3	34	1-175
90-99	25.5	540	21	21.9	25	3-60
100-109	10.2	134	13	8.2	16	2-56
110-119	9.4	207	22	8.1	26	1-42
>119	21.4	162	8	16.9	10	1-37
TOTAL	319.4	3,613		170.0		1-200
AVERAGES			11		21	

noted were *P. borealis*, *P. hypsinotus*, *P. platyceros* and *Pandalopsis dispar*.

As in Southeastern Alaska, *Pandalus borealis* was the dominant species. Good catches of *P. borealis* were made in bays and inlets as well as in the offshore waters of the Continental Shelf (fig. 4). Kachemak Bay in Lower Cook Inlet and Marmot Bay off Kodiak Island yielded excellent catches of *P. borealis*. Around Kodiak Island, good catches were also made in Uganik Bay, Alitak Bay, Raspberry Strait, Kukak Bay, and Shelikof Strait. Fair catches of *P. borealis* were made in Tutka Bay, West Arm of Port Dick, Taylor Bay, Nuka Passage, East and North Arms of Nuka Bay, between Nuka Island and the Pye Islands, off Ragged Island, and off Cape Douglas. No large catches of this shrimp were taken in Prince William Sound, although fair catches were made in some of the adjacent waters such as Whidby Bay, Day Harbor, Two Arm Bay, south of Puget Bay, and south of Harris Bay. *P. borealis* was relatively abundant in Yakutat Bay in depths ranging from 15 to 233 fathoms, where catches up to 510 pounds per 30 minutes of fishing were made by beam trawl.

Highest catches of *P. borealis* occurred from 30 to 109 fathoms near Kodiak Island, 30 to 119 fathoms between Cape Douglas and the Pye Islands, 50 to 79 and 100 to 119 fathoms between the Pye Islands and Prince William Sound, 30 to 39 and 70 to 89 fathoms in Prince William Sound, and 30 to 59 fathoms in Yakutat Bay (tables 8-13).

Only from the Pye Islands to Cook Inlet were sizeable catches of *P. hypsinotus* made. The greatest abundance was found in Tutka Bay on the Kenai Peninsula. Good catches were also made in the West Arm of Port Dick and Kachemak Bay. One good catch was made in Uganik Bay, Kodiak Island. Table 14 gives the average catch per unit of effort by 10-fathom intervals for this species taken between the Pye Islands and Cape Douglas.

TABLE 8.--Catch per unit of Gulf shrimp trawl effort by depth for *Pandalus borealis* taken in the Kodiak Island area, 1958

Depth	1/2 hour effort	Total catch	Average catch per 1/2 hour	Effort taking shrimp	Average for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
<30	0	0	0	0	0	--
30-39	1	700	700	1	700	700
40-49	2	950	475	2	475	330-620
50-59	0	0	0	0	0	--
60-69	4	1,397	349	3	466	301-649
70-79	5	1,544	309	5	309	94-665
80-89	4	605	151	4	151	29-270
90-99	7	2,955	422	6	493	56-1,196
100-109	15	1,803	120	15	120	3-533
>109	17	422	25	16	26	1-91
TOTAL	55	10,376		52		1-1,196
Averages			189		200	

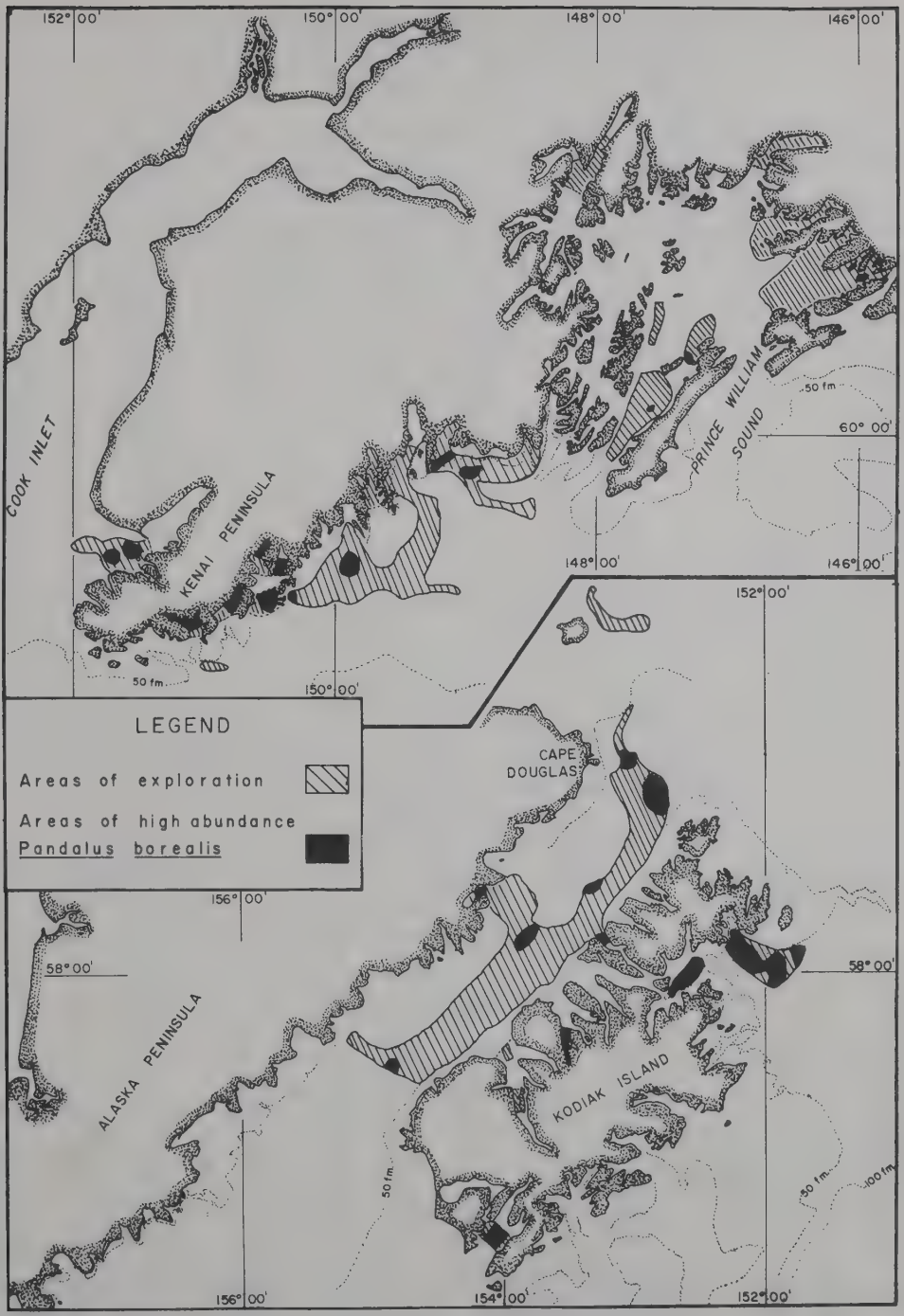

Figure 4.--Areas of exploration for and high abundance of *Pandalus borealis*, central Alaska, 1950-60.

TABLE 9.--Catch per unit of Gulf shrimp trawl effort by depth for *Pandalus borealis* taken between the Pye Islands and Cape Douglas, 1958

Depth	1/2-hr. effort	Total catch	Average catch per 1/2 hour	Effort taking shrimp	Average for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
< 30	7.0	2	0	2.0	1	1
30-39	1.5	162	108	0.5	324	162
40-49	4.0	2,684	671	4.0	671	6-1,487
50-59	3.0	490	163	3.0	163	127-219
60-69	4.0	457	114	3.0	148	2-377
70-79	5.5	999	182	5.5	182	35-444
80-89	8.0	1,623	203	7.0	232	10-461
90-99	1.5	579	386	1.5	386	358-400
100-109	1.0	0	-	0	0	--
110-119	3.0	347	116	3.0	116	76-169
> 119	7.0	876	125	6.0	146	68-198
TOTAL	45.5	8,219		35.5		1-1,487
Average			181		237	

TABLE 10.--Catch per unit of Gulf shrimp trawl effort by depth for *Pandalus borealis* taken from Prince William Sound to the Pye Islands, 1959

Depth	1/2-hr. effort	Total catch	Average catch per 1/2 hour	Effort taking shrimp	Average for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
< 50	0	0	0	0	0	--
50-59	2.0	605	303	2.0	303	275-330
60-69	6.2	416	67	6.2	67	8-149
70-79	5.0	394	79	4.0	99	12-317
80-89	4.1	90	22	4.1	22	5-52
90-99	6.3	188	30	6.3	30	9-88
100-109	8.7	714	82	8.7	82	1-220
110-119	4.8	370	81	4.8	81	1-237
> 119	7.0	100	14	6.0	17	4-34
TOTAL	44.1	2,877		42.1		1-330
Average			65		68	

TABLE 11.--Catch per unit of Gulf shrimp trawl effort by depth for *Pandalus borealis* taken in Prince William Sound, 1959

Depth	1/2-hr. effort	Total catch	Average per 1/2 hour	Effort taking shrimp	Average catch for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
<30	1.0	0	0	0	0	--
30-39	1.7	140	82	1.0	140	140
40-49	2.0	1	1	1.0	1	1
50-59	4.4	28	6	4.4	6	3-9
60-69	7.1	192	27	7.1	27	4-97
70-79	7.0	47	7	6.0	8	2-14
80-89	3.0	54	18	3.0	18	1-46
90-99	2.0	40	20	2.0	20	2-38
100-109	3.0	19	6	3.0	6	1-13
>109	8.9	68	9	7.9	9	2-34
TOTAL	40.1	589		35.4		1-140
AVERAGES			15		17	

TABLE 12.--Catch per unit of beam trawl effort by depth for *Pandalus borealis* taken in Prince William Sound during 1954

Depth	1/2-hr. effort	Total catch	Average per 1/2 hour	Effort taking shrimp	Average catch for unit taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
< 30	2.7	0	0	0	0	--
30-39	3.8	55	15	1.0	55	55
40-49	6.0	113	19	4.0	28	5-38
50-59	12.0	263	22	7.0	38	8-89
60-69	15.0	325	22	13.0	25	2-72
70-79	32.3	1,744	54	32.3	54	4-155
80-89	9.9	443	45	9.9	45	9-84
90-99	11.2	230	21	11.2	21	10-80
100-109	10.5	198	19	10.5	19	2-48
>109	11.9	114	10	8.9	13	3-60
TOTAL	115.3	3,485		97.8		2-155
AVERAGES			30		36	

TABLE 13.--Catch per unit of beam trawl effort by depth for *Pandalus borealis* taken in Yakutat Bay in 1953

Depth	1/2-hr. effort	Total catch	Average catch per 1/2 hour	Effort taking shrimp	Average for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
< 30	0.0	0	0	0	0	--
30-39	5.0	867	173	4.0	217	56-510
40-49	14.0	1,281	92	10.0	128	4-394
50-59	11.5	1,008	88	10.5	96	1-300
60-69	6 0	80	13	4.0	20	11-38
70-79	12.8	266	21	6.0	44	7-123
80-89	3.0	120	40	2.0	60	55-65
90-99	7.0	192	27	5.0	38	6-92
> 99	1.0	0	0	0	0	--
TOTAL	60.3	3,814		41.5		1-510
Averages			63		92	

TABLE 14.--Catch per unit of Gulf shrimp trawl effort by depth for *Pandalus hypsinotus* taken from Pye Islands to Cape Douglas, 1958

Depth	1/2-hr. effort	Total catch	Average catch per 1/2 hour	Effort taking shrimp	Average for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
< 30	7.0	0	0	0	0	--
30-39	1.5	45	30	0.5	90	45
40-49	4.0	384	96	3.0	128	15-318
50-59	3.0	89	30	2.0	45	32-57
60-69	4.0	64	16	2.0	32	2-37
70-79	5.5	155	28	4.5	34	17-108
80-89	8.0	169	21	4.0	42	19-94
90-99	1.5	3	2	1.0	3	3
100-109	1.0	0	0	0	0	--
110-119	3.0	42	14	3.0	14	10-19
> 119	7.0	11	1	3.0	4	2-6
TOTAL	45.5	962		23.0		2-318
Average			21		42	

P. platyceros was not commonly taken in the central Alaska area, and Port Dick was the most northwesterly point at which it was captured at all.

Pandalopsis dispar was caught throughout the central Alaska area. The best catches occurred in Nuka Passage and Kukak Bay. Other places producing good catches of this species were Aialik Bay, Resurrection Bay, Day Harbor, south of Harris Bay, as well as Port Dick, Kachemak Bay, East Arm of Nuka Bay, off Cape Douglas, Ragged Island, Marmot Bay, Shelikof Strait, and Uyak Bay. *P. dispar* was found in central Alaskan waters at depths from 22 to 233 fathoms with the better catches generally occurring from about 60 to 119 fathoms (tables 15-20).

Alaska Peninsula

In 1957 the waters adjacent to the Shumagin Islands and the Alaska Peninsula from Stepovak Bay to Unalaska were explored, and sampling was conducted at depths ranging from 19 to 124 fathoms.

Pandalus borealis was again dominant, and the abundance of *P. borealis* (up to 3,500 pounds per 30 minutes of fishing) was the greatest found in any area explored. Highest catches occurred in Pavlof Bay. High abundance was also noted in Beaver Bay, Balboa Bay, near Seallion Rocks, and Stepovak Bay (fig. 5). *P. borealis* was taken at depths ranging from 30 to 99 fathoms, with the best catches between 40 and 79 fathoms (table 21).

P. hypsinotus also occurred in fair quantities. Good catches were made in Beaver Bay, Balboa Bay, Pavlof Bay, Stepovak Bay, and near Seallion Rocks. *P. hypsinotus* was taken at depths of 30 to 99 fathoms, with highest catches from 40 to 79 fathoms (table 22).

Pandalopsis dispar was taken in fair quantities. Good catches were made near Seallion Rocks. Relatively high abundance was also noted in Pavlof Bay, Beaver Bay, and off Balboa Bay. Highest catches of this species were made in 50 to 79 fathoms (table 23).

Pandalus platyceros was not taken in the waters adjacent to the Alaska Peninsula.

TABLE 15.--Catch per unit of Gulf shrimp trawl effort by depth for *Pandalopsis dispar* taken in the Kodiak Island area, 1959

Depth	1/2-hr. effort	Total catch	Average per 1/2 hour	Effort taking shrimp	Average catch for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
< 50	3	155	52	2	78	65-90
50-59	0	0	0	0	0	--
60-69	4	165	116	1	465	465
70-79	5	375	75	5	75	13-188
80-89	4	215	54	4	54	16-113
90-99	7	715	102	6	119	30-264
100-109	15	1,325	88	15	88	5-220
110-119	13	395	30	12	32	8-59
> 119	4	293	73	4	73	9-134
TOTAL	55	3,938		49		5-465
AVERAGES			72		80	

TABLE 16.--Catch per unit of Gulf shrimp trawl effort by depth for *Pandalopsis dispar* taken from the Pye Islands to Cape Douglas, 1958

Depth	1/2-hr. effort	Total catch	Average per 1/2 hour	Effort taking shrimp	Average catch for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
< 50	12.5	193	15	1.0	193	193
50-59	3.0	308	103	3.0	103	17-181
60-69	4.0	367	92	2.0	184	8-359
70-79	5.5	537	98	4.5	119	52-262
80-89	8.0	1,327	166	7.0	190	4-285
90-99	1.5	256	171	1.5	171	56-200
100-109	1.0	0	0	0	0	--
110-119	3.0	471	157	3.0	157	148-173
> 119	7.0	565	81	6.0	94	62-106
TOTAL	45.5	4,024		28.0		4-359
AVERAGES			89		144	

TABLE 17.--Catch per unit of Gulf shrimp trawl effort by depth for *Pandalopsis dispar* taken from Prince William Sound to Pye Islands, 1959

Depth	1/2-hr. effort	Total catch	Average per 1/2 hour	Effort taking shrimp	Average catch for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
< 50	0.0	0	0	0	0	--
50-59	2.0	0	0	0	0	--
60-69	6.2	44	7	4.5	10	2-18
70-79	5.0	91	18	4.0	23	9-48
80-89	4.1	40	10	4.1	10	4-24
90-99	6.3	142	23	6.3	23	2-68
100-109	8.7	258	30	6.7	39	1-118
110-119	4.8	95	20	4.8	95	1-63
> 119	7.0	259	37	7.0	37	4-75
TOTAL	44.1	929		37.4		1-118
AVERAGES			21		25	

TABLE 18.--Catch per unit of Gulf shrimp trawl effort by depth for *Pandalopsis dispar* taken in Prince William Sound, 1959

Depth	1/2-hr. effort	Total catch	Average per 1/2 hour	Effort taking shrimp	Average catch for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
< 50	4.7	24	5	0.7	34	24
50-59	4.4	3	1	3.4	1	1
60-69	7.1	57	8	7.1	8	1-28
70-79	7.0	48	7	6.0	8	4-10
80-89	3.0	49	16	2.0	45	8-34
90-99	2.0	89	45	2.0	45	35-51
100-109	3.0	12	4	3.0	4	1-7
110-119	3.0	12	4	3.0	4	3-5
> 119	5.9	97	16	3.9	25	8-41
TOTAL	40.1	391		31.1		1-51
AVERAGES			10		13	

TABLE 19.--Catch per unit of beam trawl effort by depth for *Pandalopsis dispar* taken in Prince William Sound, 1954

Depth	1/2-hr. effort	Total catch	Average per 1/2 hour	Effort taking shrimp	Average catch for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
< 50	12.5	0	0	0.0	0	--
50-59	12.0	3	0	1.0	3	3
60-69	15.0	16	1	4.0	4	1-8
70-79	32.3	124	4	22.3	6	2-14
80-89	9.9	56	6	9.9	6	1-16
90-99	11.2	114	10	11.2	10	2-45
100-109	10.5	79	7	10.5	7	1-18
110-119	6.9	83	12	4.9	16	3-42
> 119	5.0	12	2	4.0	3	2-5
TOTAL	115.3	487		67.8		1-45
AVERAGES			4		7	

TABLE 20.--Catch per unit of beam trawl effort by depth for *Pandalopsis dispar* taken in Yakutat Bay, 1953

Depth	1/2-hr. effort	Total catch	Average per 1/2 hour	Effort taking shrimp	Average catch for units taking shrimp	Range of catches over 1 pound
< 50	19.0	50	3	6.0	8	1-18
50-59	11.5	147	13	6.0	25	3-62
60-69	6.0	167	28	6.0	28	18-37
70-79	12.8	288	23	12.8	23	3-71
80-89	3.0	114	38	2.0	57	53-61
90-99	7.0	227	32	7.0	32	10-52
> 99	1.0	9	9	1.0	9	9
TOTAL	60.3	1,002		40.8		1-71
AVERAGES			17		25	

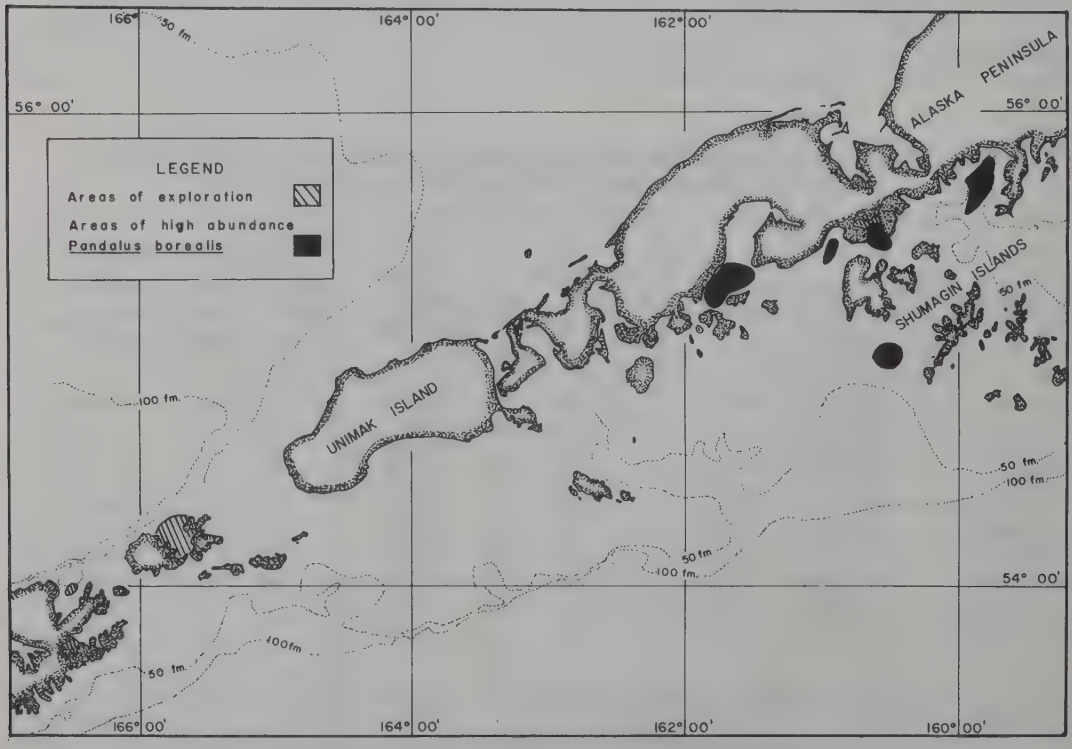

Figure 5.--Areas of exploration for and high abundance of *Pandalus borealis*, western Alaska, 1950-60.

TABLE 21.--Catch per unit of Gulf shrimp trawl effort by depth for *Pandalus borealis* in the Shumagin Islands - Alaska Peninsula area, 1957

Depth	1/2-hr. effort	Total catch	Average per 1/2 hour	Effort taking shrimp	Average catch for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
< 40	2.7	2	1	1.0	2	2
40-49	1.7	1,350	794	0.7	1,929	1,350
50-59	5.0	10,105	2,021	4.0	5,526	1,020-3,500
60-69	11.7	16,600	1,419	10.7	1,551	450-3,300
70-79	5.0	5,033	1,007	5.0	1,007	165-2,850
80-89	1.0	170	170	1.0	170	170
90-99	1.0	90	90	1.0	90	90
> 99	0.0	0	0	0	0	--
TOTAL	28.1	33,350		23.4		2-3,500
AVERAGES			1,187		1,425	

TABLE 22.--Catch per unit of Gulf shrimp trawl effort by depth for *Pandalus hypsinotus* taken in Shumagin Islands - Alaska Peninsula area, 1957

Depth	1/2-hr. effort	Total catch	Average per 1/2 hour	Effort taking shrimp	Average catch for units taking shrimp	Range of catches over 1 pound
Fm.	*Units*	*Pounds*	*Pounds*	*Units*	*Pounds*	*Pounds*
< 40	2.7	1	0	1.0	1	1
40-49	1.7	50	29	0.7	71	50
50-59	5.0	116	23	3.3	35	1-50
60-69	11.7	852	73	11.0	77	4-280
70-79	5.0	215	43	5.0	43	5-120
80-89	1.0	5	5	1.0	5	5
90-99	1.0	20	20	1.0	20	20
> 99	0.0	0	0	0	0	--
TOTAL	28.1	1,259		22.0		1-280
AVERAGES			45		57	

TABLE 23.--Catch per unit of Gulf shrimp trawl effort by depth for *Pandalopsis dispar* taken in the Shumagin Islands - Alaska Peninsula area, 1957

Depth	1/2-hr. effort	Total catch	Average per 1/2 hour	Effort taking shrimp	Average catch for units taking shrimp	Range of catches over 1 pound
< 50	4.4	0	0	0.0	0	--
50-59	5.0	505	101	3.3	153	30-315
60-69	11.7	965	83	10.0	97	3-262
70-79	5.0	682	136	3.3	207	3-400
80-89	1.0	25	25	1.0	25	25
90-99	1.0	60	60	1.0	60	60
> 99	0.0	0	0	0.0	0	--
TOTAL	28.1	2,237		18.6		3-400
AVERAGES			80		120	

INTERAREA DISTRIBUTION AND RELATIVE ABUNDANCE

P. jordani was taken from off the Coquille River, Oreg., to Glacier Bay in Southeastern Alaska at depths ranging from 20 to 247 fathoms. Highest catch rates occurred off the Oregon and Washington coasts where the species was commonly taken in depths 60 to 100 fathoms. Highest availability of *Pandalus jordani* was found to occur in somewhat deeper water off Oregon than off Washington (fig. 6). *P. jordani* also comprises the bulk of the catch taken in the California offshore shrimp fisheries. Apparently this species is abundant in waters from about central California to at least Cape Beale, Vancouver Island, but it was not taken in significant concentrations in the waters of Southeastern or central Alaska. Throughout the region, concentrations of *P. jordani* generally occur where green (glauconite mud) mud is the dominant bottom type.

P. borealis was captured from Southeastern Alaska west to the Alaskan Peninsula at depths from 11 to 233 fathoms. It was by far the most abundant species throughout these waters. Highest catch rates occurred in the central Alaskan and Alaska Peninsula areas (fig. 7). In

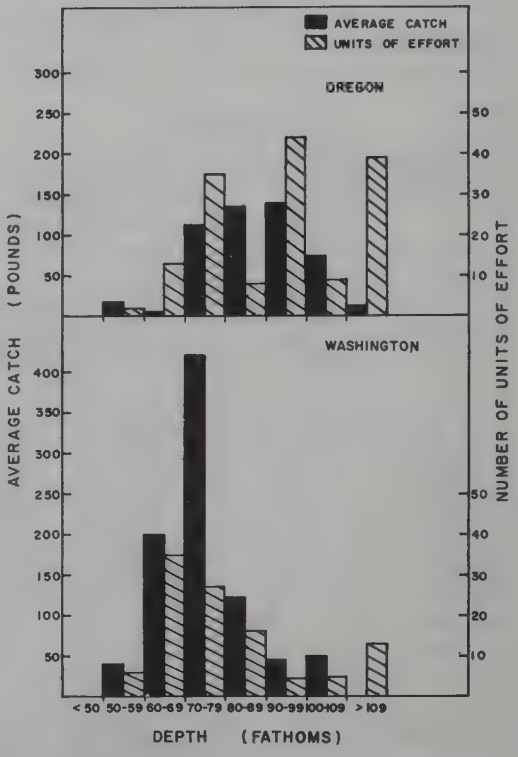

Figure 6.--Average catch in pounds per 30 minutes fished, by depth, for *Pandalus jordani*.

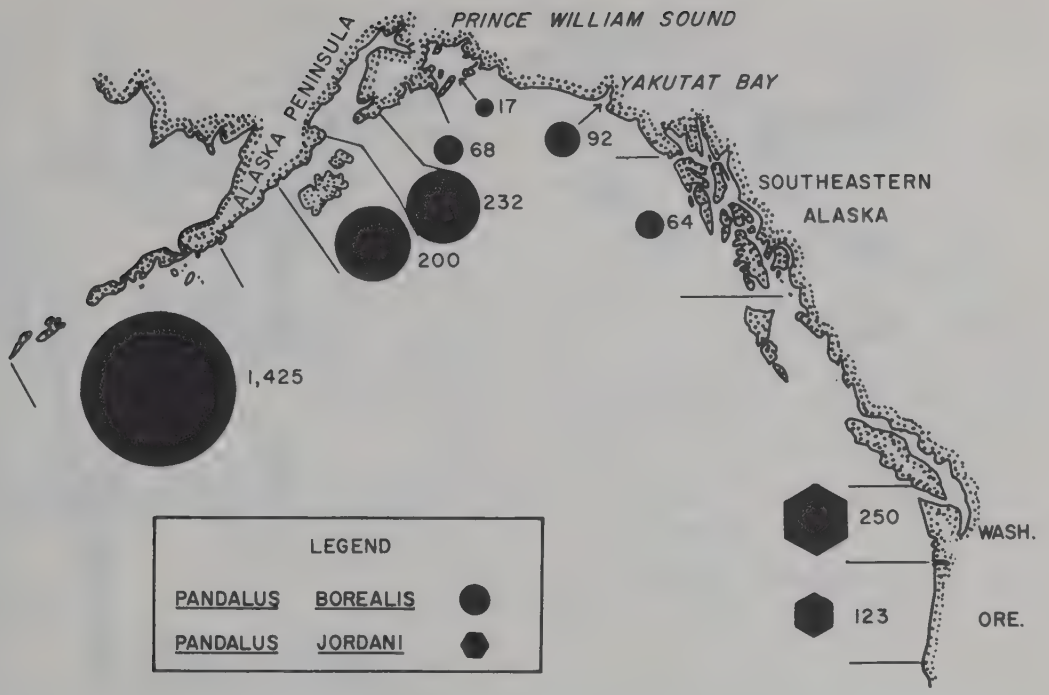

Figure 7.--Average catch in pounds per 30 minutes fished by area for *Pandalus borealis* and *P. jordani*, based on hauls producing one pound or more.

other exploratory fishing activities *P. borealis* has been captured as far south as Puget Sound, Wash.

Thus *P. jordani,* the dominant species in southern waters, is replaced as the dominant species by *P. borealis* in northern waters, with the transition occurring off British Columbia.

P. hypsinotus was found in all portions of the region surveyed, and *P. platyceros* was captured in all portions surveyed south and east of Cook Inlet. Members of these species are a minor portion of the total catch taken in trawls, but traps and pots, which were set in rocky areas, caught fair quantities of both.

Pandalopsis dispar was taken from Manhattan Beach, Oreg., to the Alaska Peninsula in depths of 20 to 233 fathoms. As with *P. borealis* this species was also found to be most abundant in the central Alaskan and Alaska Peninsula areas (fig. 8). *P. dispar* was generally taken in somewhat deeper than *P. borealis* (figs. 9-12).

P. jordani, P. borealis, and *Pandalopsis dispar* appear to occur in concentrations adequate to support large-scale commercial operations. *Pandalus platyceros,* which grows to a size comparable with the size of Gulf of Mexico penaeid shrimps, may be available in sufficient quantities over rocky, rough bottoms to warrant small-scale pot fisheries. *P. jordani* is already extensively fished off the California, Oregon, and Washington coasts, while *P. borealis* is harvested in the waters of Southeastern and central Alaska. The results of Bureau explorations suggest that *P. borealis* and *Pandalopsis dispar* may reach maximum abundance levels in waters adjacent to the Alaska Peninsula, along the Aleutian Islands, and in the Bering Sea. The commercial potential of these species may be many times greater than is now realized. Distance from markets and other economic factors obviously will affect utilization of the species.

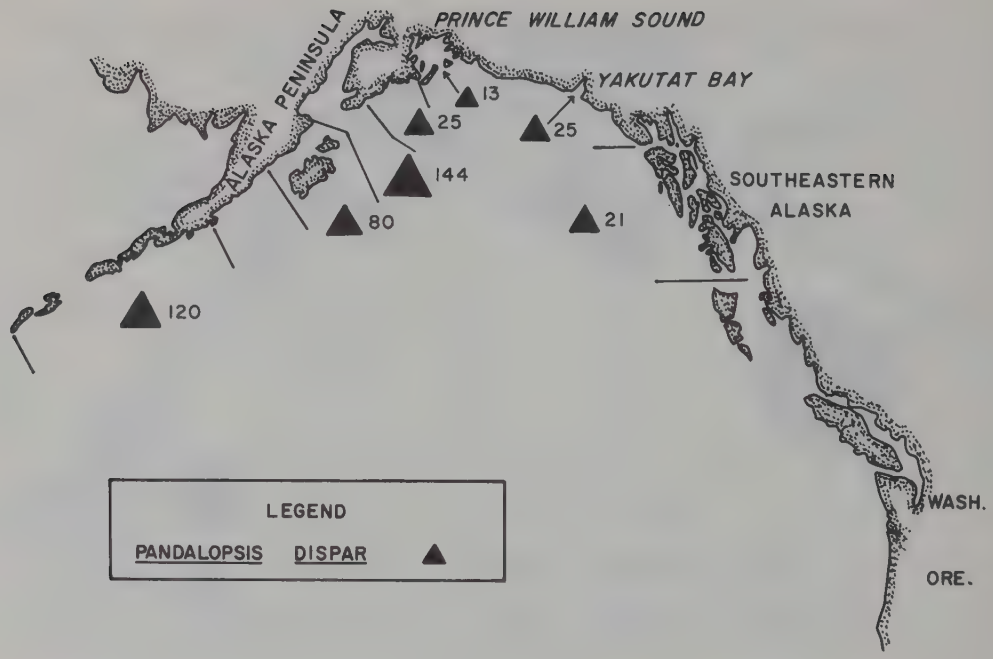

Figure 8.--Average catch in pounds per 30 minutes fished by area for *Pandalopsis dispar*, based on hauls producing one pound or more.

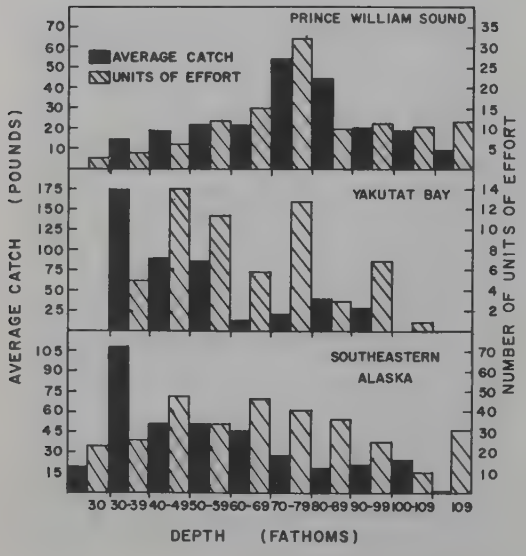

Figure 9.--Average catch per 30 minutes fished by depth for *Pandalus borealis* taken by beam trawls.

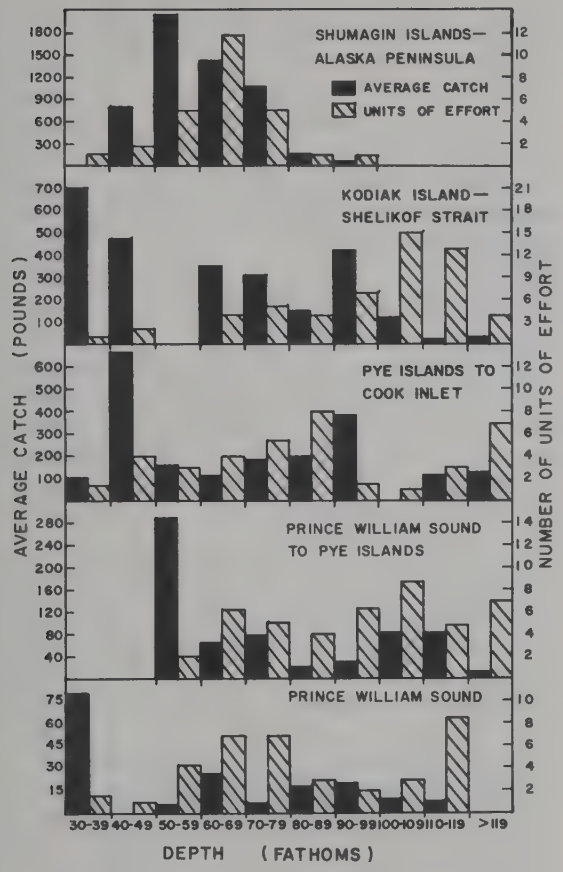

Figure 10.--Average catch per 30 minutes fished by depth for *Pandalus borealis* taken by Gulf shrimp trawl.

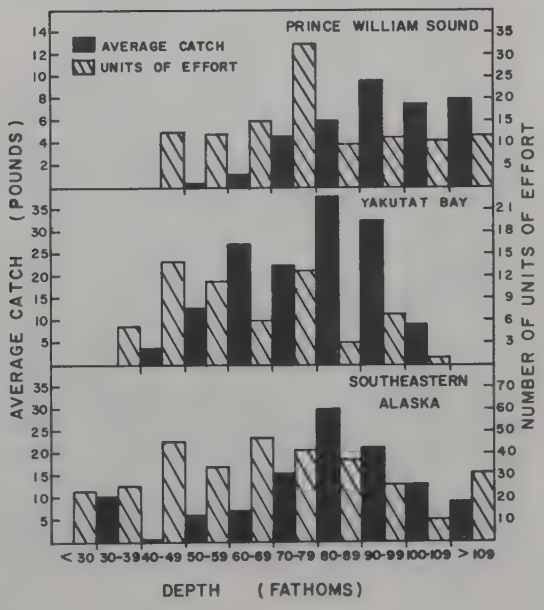

Figure 11.--Average catch per 30 minutes fished by depth for *Pandalopsis dispar* taken by beam trawl.

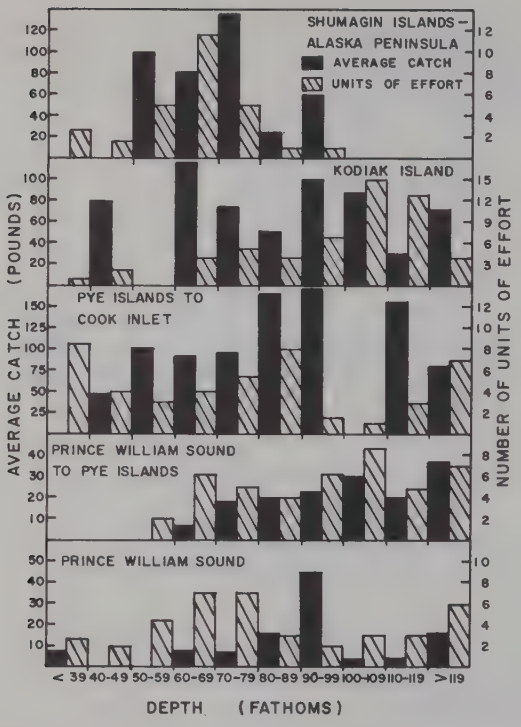

Figure 12.--Average catch per 30 minutes fished by depth for *Pandalopsis dispar* taken by Gulf shrimp trawl.

SUMMARY

Eighteen exploratory shrimp cruises were made in the waters of the northeastern Pacific by the Bureau of Commercial Fisheries in 1950-60. The principal gear used were beam trawls and Gulf of Mexico shrimp trawls.

Along the Oregon-Washington coast, *Pandalus jordani* was the dominant species. Best catches were made in 60 to 109 fathoms. Other species taken included: *Pandalopsis dispar,* north of Manhattan Beach, Oreg.; *Pandalus platyceros* north of Lapush, Wash.; and *P. hypsinotus* in the Strait of Juan de Fuca.

Throughout Southeastern Alaska, *P. borealis* is the most abundant species, followed by *Pandalopsis dispar.* Highest availability was found between 30 and 70 fathoms. Other species found in the Southeastern Alaska area were *Pandalus jordani, Pandalopsis dispar, P. hypsinotus,* and *P. platyceros.*

In central Alaska, *P. borealis* was also the dominant species. Highest catches were made between 30 and 119 fathoms. Other species taken were *Pandalopsis dispar, Pandalus hypsinotus,* and *P. platyceros. P. platyceros* was not taken west of Port Dick, Alaska.

In the Shumagin Islands-Alaska Peninsula area, *P. borealis* was again the dominant species, with the highest availability occurring between 40 and 79 fathoms. Other species occurring in this area were *Pandalopsis dispar* and *Pandalus hypsinotus.*

P. jordani, the most abundant species off Washington and Oregon, was taken from off the Coquille River, Oreg., to Southeastern Alaska with the highest availability occurring off Washington. *P. borealis* was found from Southeastern Alaska to the Alaska Peninsula, and it was the most abundant species taken off Alaska. Catch rates were highest in the Alaska Peninsula-Shumagin Islands area. *Pandalopsis dispar* was taken from Manhattan Beach, Oreg., to the Alaska Peninsula. Although the abundance of *P. dispar* does not compare with *Pandalus jordani* or *P. borealis,* it is available in commercial quantities, and good catches were made from Cook Inlet to the Pye Islands of central Alaska. *P. hypsinotus,* taken from the Strait of Juan de Fuca to the Alaska Peninsula, and *P. platyceros,* taken from off Lapush, Wash., to Port Dick, Alaska, were never found in large concentrations. Adult populations appear to be most abundant in rocky areas where they are not fishable by trawls.

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